

Claims:

1. A steelmaking process that includes the steps of:

(a) producing molten steel and molten steelmaking slag in a steelmaking process in a steelmaking vessel, the steelmaking slag including iron units and flux units; and

(b) producing molten iron in a direct smelting process in a direct smelting vessel containing a molten bath of iron and slag using a substantial portion of the steelmaking slag as part of the feed material requirements for the direct smelting process.

2. The process defined in claim 1 wherein step (b) includes using at least 70% by weight of the steelmaking slag as part of the feed material requirements for the direct smelting process.

3. The process defined in claim 1 wherein step (b) includes using at least 80% by weight of the steelmaking slag as part of the feed material requirements for the direct smelting process.

4. The process defined in claim 1 wherein step (b) includes using at least 90% by weight of the steelmaking slag as part of the feed material requirements for the direct smelting process.

5. The process defined in any one of the preceding claims wherein step (b) includes using sufficient steelmaking slag to provide at least 50% by weight of the flux units of the feed material requirements of the direct smelting process.

6. The process defined in any one of the preceding claims wherein the process is an integrated steelmaking process and includes producing molten iron in at least one ironmaking vessel and supplying the molten iron as a ferrous feed material for step (a).

7. The process defined in any one of the preceding claims includes using iron produced in step (b) as at least part of the ferrous feed material for producing steel in step (a).

8. The process defined in any one of the preceding claims includes using iron produced in step (b) and in at least one other ironmaking vessel as the ferrous feed material for producing steel in step (a).

9. The process defined in any one of the preceding claims wherein step (b) includes controlling the direct smelting process to smelt the ferrous feed material and substantially partition phosphorus to the slag.

10. The process defined in any one of the preceding claims wherein the direct smelting process is a HIs melt process.

11. The process defined in any one of the preceding claims includes pre-treating ferrous feed material including steelmaking slag containing iron and flux units for step (b) by at least heating the ferrous feed material in a pre-treatment unit.

12. The process defined in claim 12 wherein the pre-treatment step includes preheating the ferrous feed material to at least 400°C.

13. The process defined in claim 12 wherein the pre-treatment step includes preheating the ferrous feed

material to at least 700°C.

14. The process defined in any one of claims 11 to 13 wherein the pre-treatment step includes preheating the ferrous feed material to a temperature less than 1050°C.

15. The process defined in any one of claims 11 to 13 wherein the pre-treatment step includes preheating the ferrous feed material to a temperature less than 900°C.

16. The process defined in any one of claims 11 to 15 wherein the pre-treatment step includes wet scrubbing an offgas produced in the step and using wet sludge containing steelmaking slag in the process.

17. The process defined in any one of the preceding claims wherein the direct smelting process includes using a slag forming agent to provide flux units for the process in addition to the flux units provide by the steelmaking slag.

18. The process defined in claim 17 wherein the direct smelting process includes injecting the slag forming agent directly into the direct smelting vessel as opposed to pretreating the slag forming agent before injection into the vessel as is the case with the steelmaking slag.

19. The process defined in claim 18 wherein the amount of the slag forming agent injected directly into the direct smelting vessel is sufficient to provide up to 30% by weight of the flux requirements.

20. The process defined in any one of claims 17 to 19 wherein the additional slag forming agent includes calcium oxide.

21. The process defined in any one of the preceding claims includes cooling the steelmaking slag produced in step (a) prior to using at least a portion of the steelmaking slag in step (b).

22. The process defined in claim 21 further includes reducing the size of the cooled steelmaking slag prior to adding the steelmaking slag in step (b).

23. A steelmaking plant for producing molten steel in accordance with the integrated steelmaking process defined in any one of the preceding claims that includes:

(a) a steelmaking apparatus for producing molten steel and molten steelmaking slag;

(b) an ironmaking apparatus for producing molten iron.

24. A direct smelting process for producing molten iron in a direct smelting vessel containing a molten bath of iron and slag, the process including the steps of:

(a) pre-treating ferrous feed material including steelmaking slag containing iron and flux units in a pre-treatment unit by at least heating the ferrous feed material; and

(b) direct smelting molten iron in a direct smelting vessel containing a molten bath of iron and slag using the pre-treated ferrous feed material including steelmaking slag from step (a) as part of the feed material requirements for the direct smelting vessel.

25. The process defined in claim 24 wherein step (a) includes heating and at least partially reducing the ferrous feed material.

26. The process defined in claim 24 or claim 25 wherein step (a) includes heating the ferrous feed material to at least 400°C.

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27. The process defined in claim 24 or claim 25 wherein step (a) includes heating the ferrous feed material to at least 700°C.

10 28. The process defined in any one of claims 24 to 27 wherein step (a) includes preheating the ferrous feed material to a temperature less than 1050°C.

15 29. The process defined in any one of claims 24 to 27 wherein step (a) includes preheating the ferrous feed material to a temperature less than 900°C.

20 30. The process defined in any one of claims 24 to 29 wherein step (a) includes wet scrubbing an offgas produced in the step and using wet sludge containing steelmaking slag in the process.

25 31. The process defined in any one of claims 24 to 30 wherein step (b) includes using a slag forming agent to provide flux units for the process in addition to the flux units provide by the steelmaking slag.

30 32. The process defined in claim 31 wherein step (b) includes injecting the slag forming agent directly into the direct smelting vessel as opposed to pretreating the slag forming agent before injection into the vessel as is the case with the steelmaking slag.

35 33. The process defined in claim 31 or claim 32 wherein the amount of the slag forming agent injected directly into the direct smelting vessel is sufficient to provide up to 30% by weight of the flux requirements.

34. The process defined in any one of claims 31 to 33 wherein the additional slag forming agent includes calcium oxide.

5 35. The process defined in any one of claims 24 to 34 wherein step (b) includes controlling conditions within the direct smelting vessel to smelt the ferrous feed material to iron in the bath and to substantially partition phosphorus to the slag.

10 36. The process defined in any one of claims 24 to 35 wherein step (b) includes controlling conditions within the direct smelting vessel to partition phosphorus to the slag by maintaining the slag in an oxidising condition
15 whereby the partition ratio of phosphorus in the iron to phosphorus in the slag is at least 1:5.

20 37. The process defined in any one of claims 24 to 36 wherein step (b) includes controlling conditions within the direct smelting vessel to partition phosphorus to the slag by maintaining the slag temperature to be in the range of 1350 - 1450°C and the amount of FeO in the slag to be at least 3% by weight.